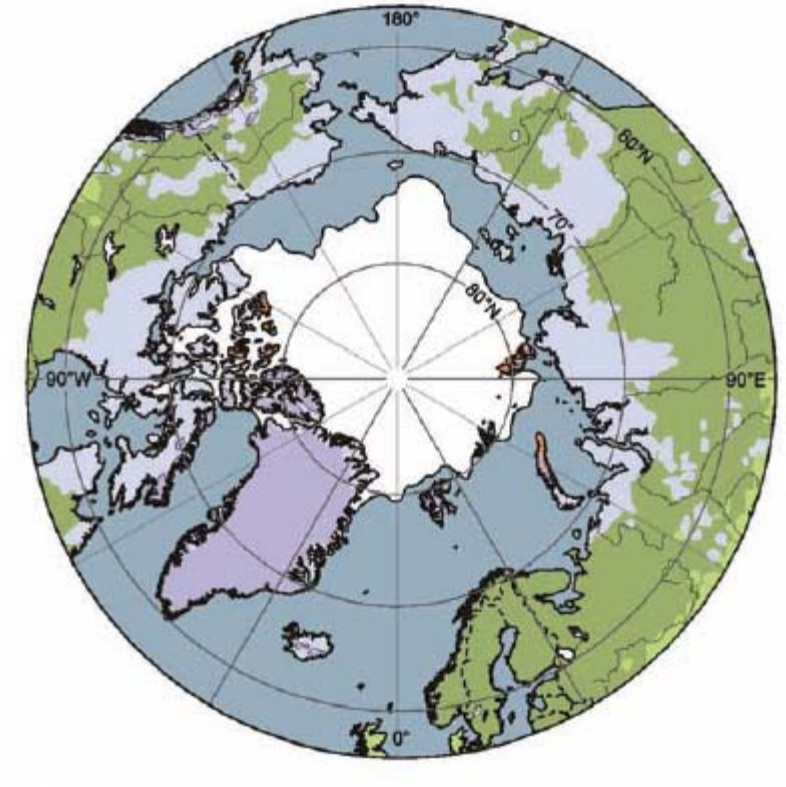
Predicting Responses of Arctic Plants to Warming with Species Distribution Maps

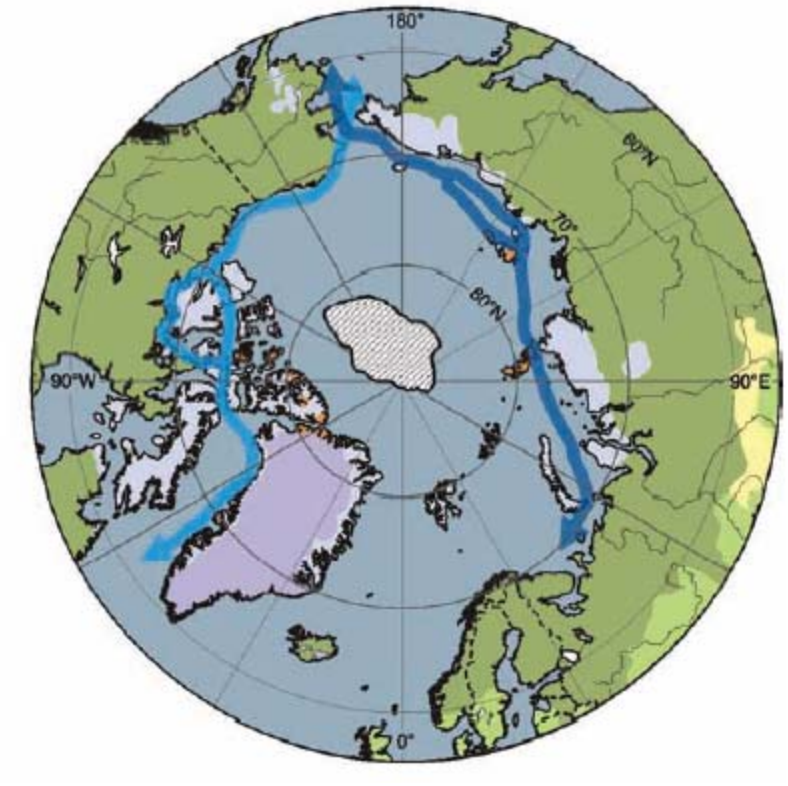
Jenny Liebig, Jeremy May & Bob Hollister

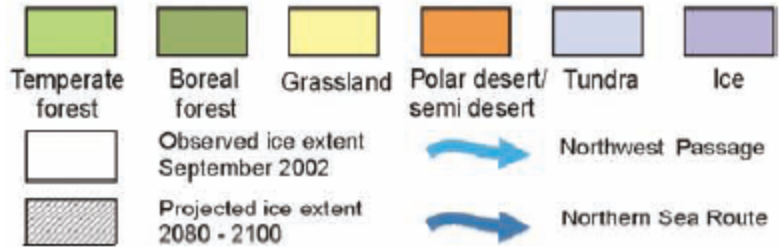
GVSU Student Scholars Day 2010

Arctic Conditions (2002)



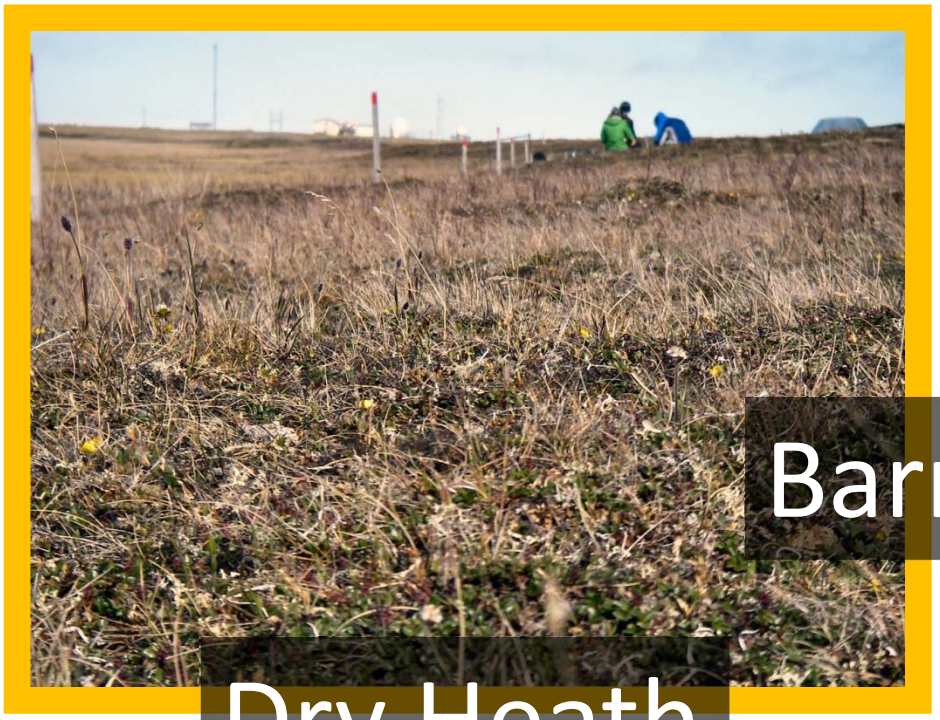
Projected Change (2080-2100)





Source: IPCC 2007

Site Locations

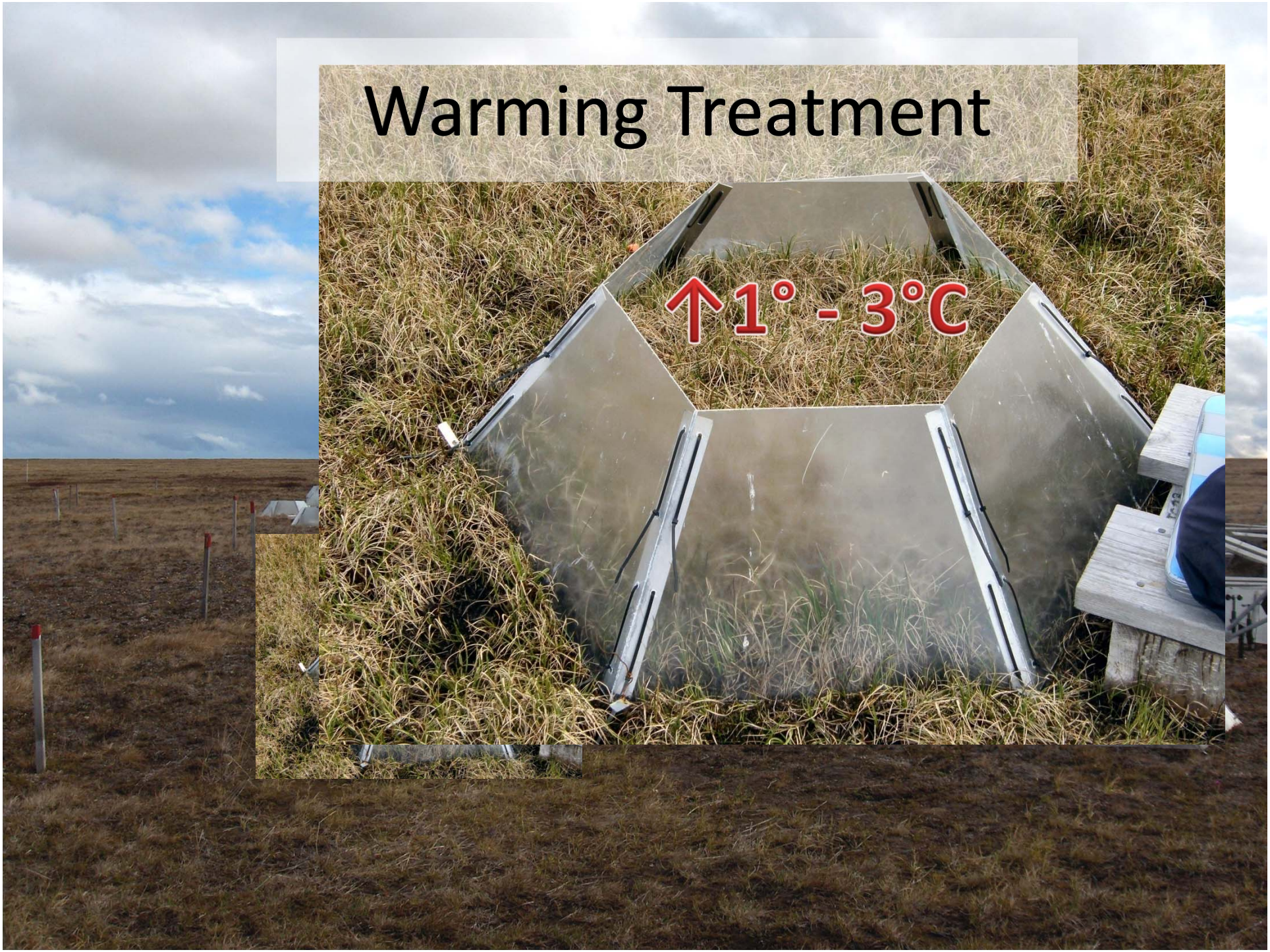

Barrow


Wet Meadow


Dry Heath

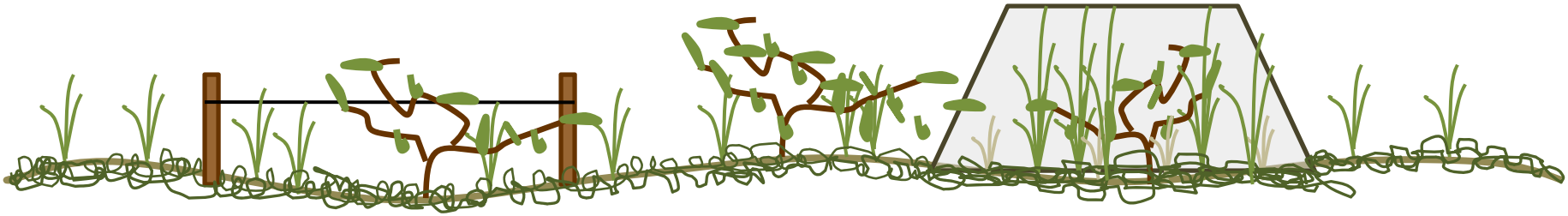

Atqasuk

Warming Treatment



Community Change (Point Frame Method)

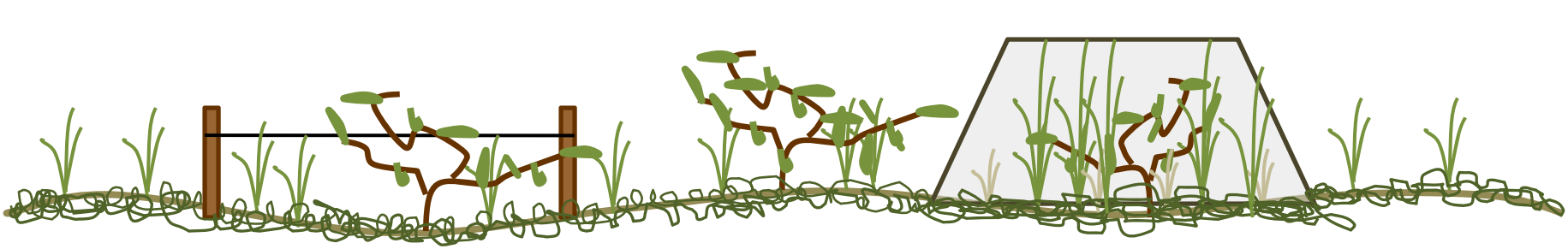
How does cover change?



In general, warming causes:

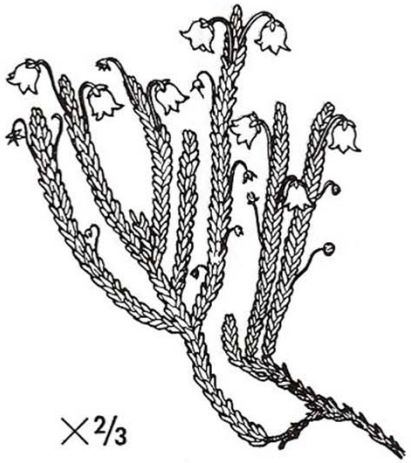
- Increase in cover
- Increase in height
- Increase in litter and standing dead
- Decrease in mosses and lichens

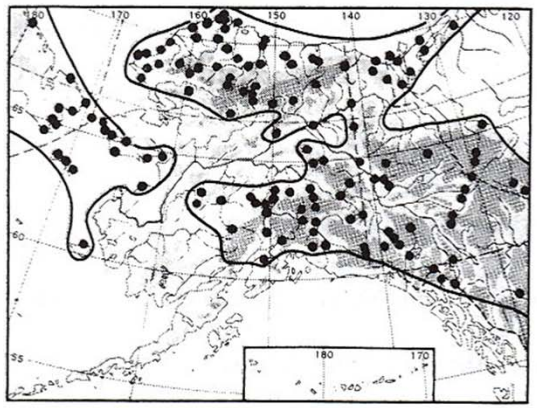
Even when a site does not respond as described above, there are increases and decreases in species within a growth form that cancel each other out

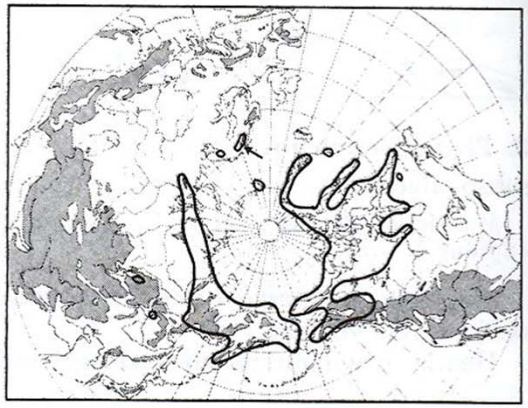


Is geography a good predictor of community response to warming?

Eric Hultén : *Flora of Alaska and Neighboring Territories* (1968)







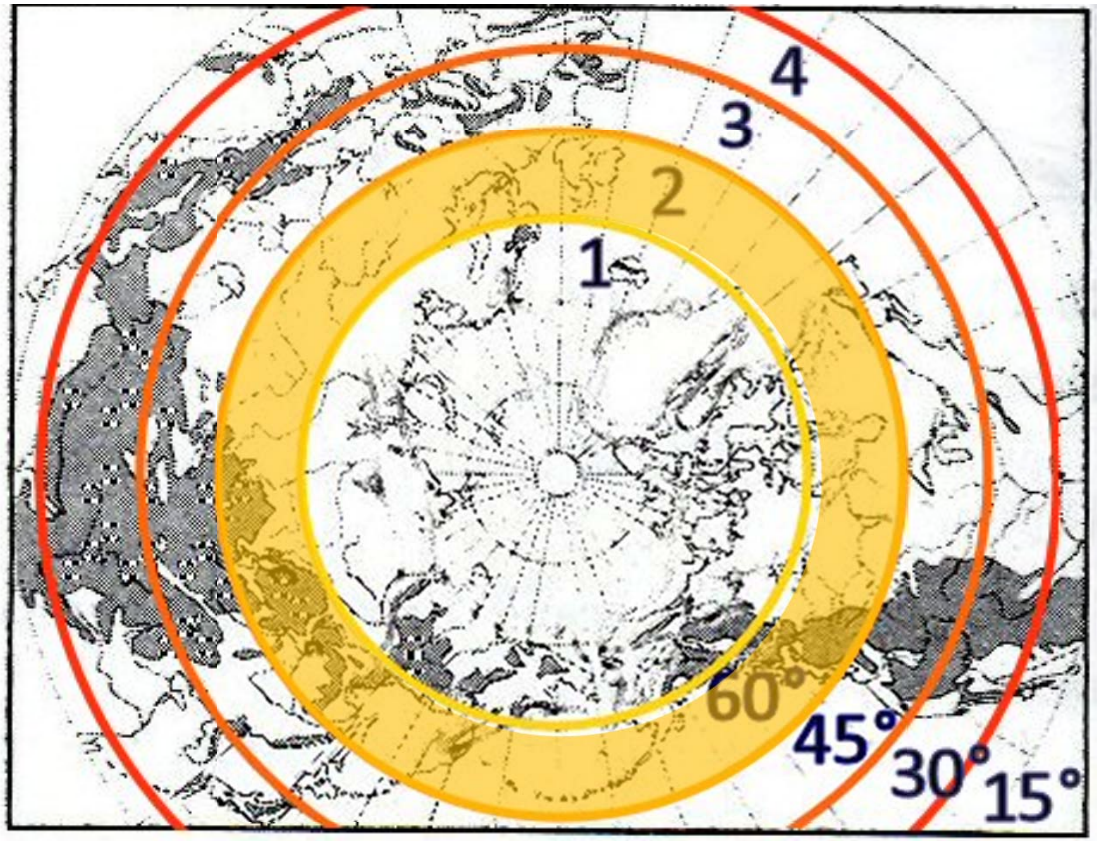
1. Cassìope tetragòna (L.) D. Don — Lapland Cassiope

Andromeda tetragona L.

subsp. **tetragòna**

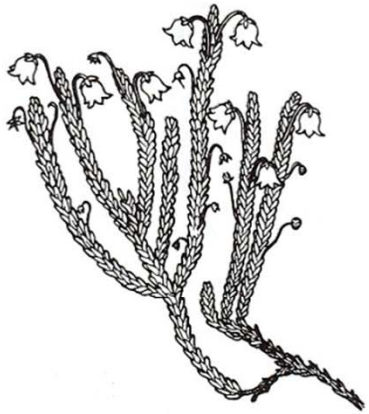
Coarse, dark-green dwarf shrub; leaves in 4 rows, lanceolate, deeply grooved dorsally, puberulent, ciliolate; pedicels long, glabrous; calyx lobes reddish; corolla bell-shaped.

Dry heaths and rocks on tundra or in the mountains, to at least 2,000 meters. Common in the North.



Latitudinal Distribution
Hultén 1968

Cassiope tetragona
(Group 2)



1: Southern limit north of 60°N

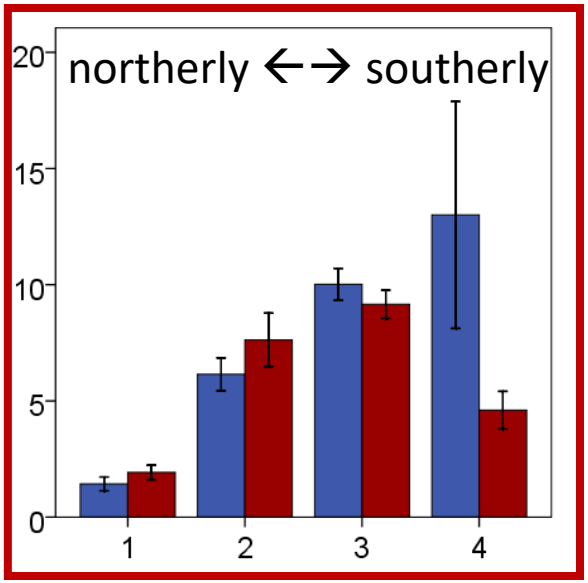
2: Southern limit between 60°N and 45°N

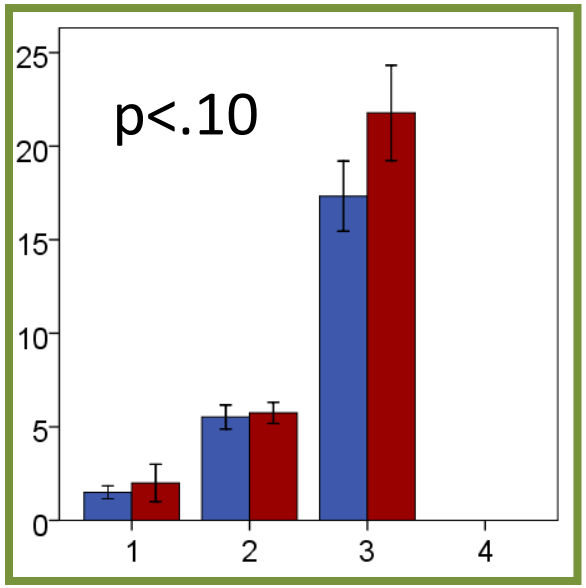
3: Southern limit between 45°N and 30°N

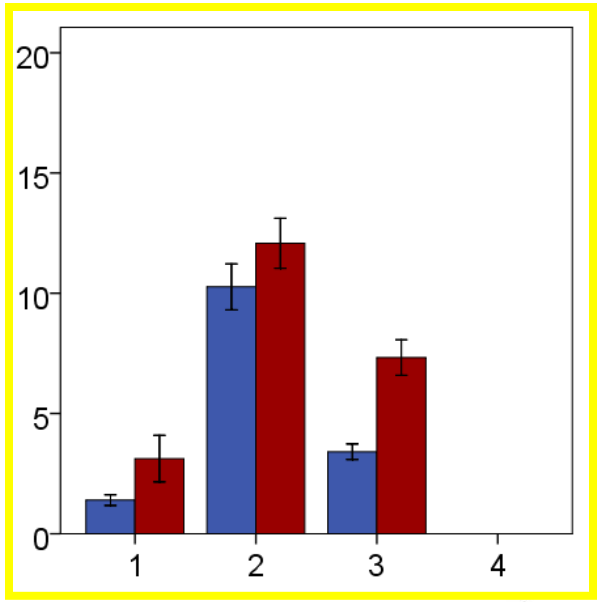
4: Southern limit between 30°N and 15°N

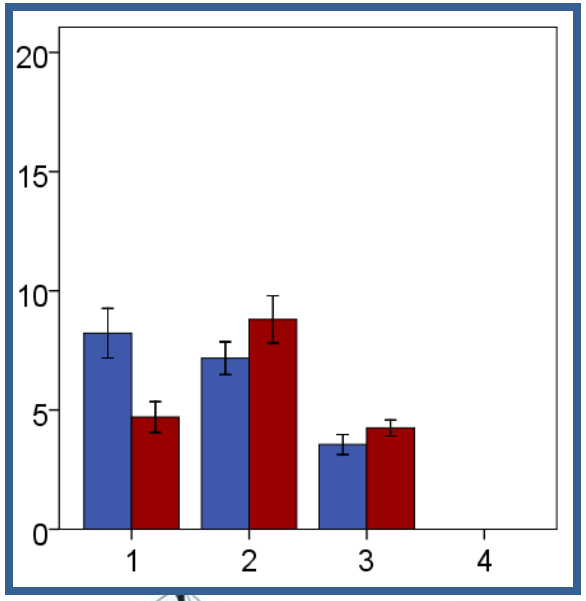
Latitudinal distribution

Cover (hits per plot)







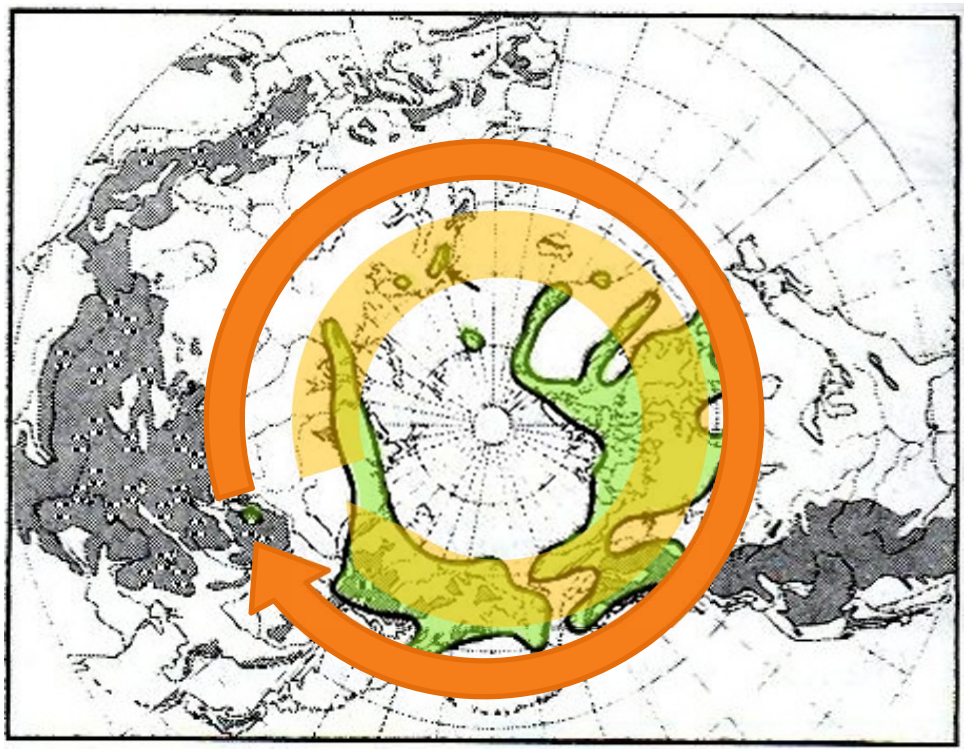


Results

	Latitudinal Distribution
All Sites Combined	
Atqasuk Dry	
Atqasuk Wet	.
Barrow Dry	
Barrow Wet	

This grouping scheme shows a trend at the Atqasuk wet site, but does not produce significant results and is not a good tool for predicting plant response to warming.

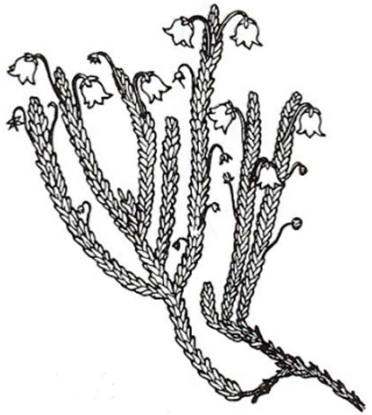
*p<.05, ·p<.10



Longitudinal Distribution

Hultén 1968

Cassiope tetragona
(Group 1)



1: Present at all longitudes

2: Not present at all longitudes

Longitudinal distribution

Atqasuk Dry

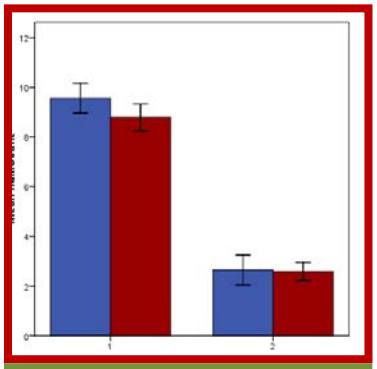
Atqasuk Wet

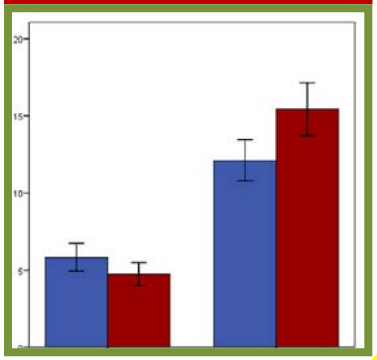
Barrow Dry

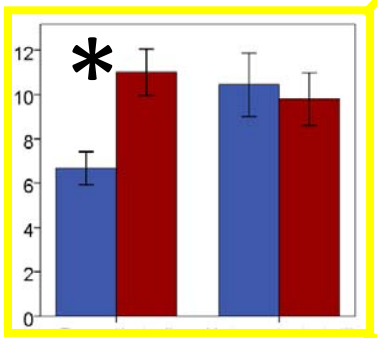
Barrow Wet

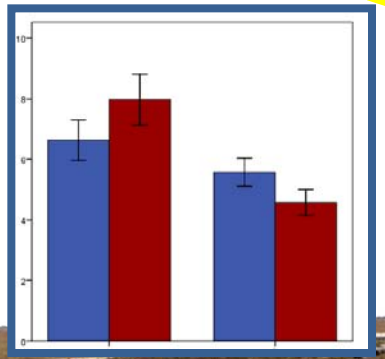
Control

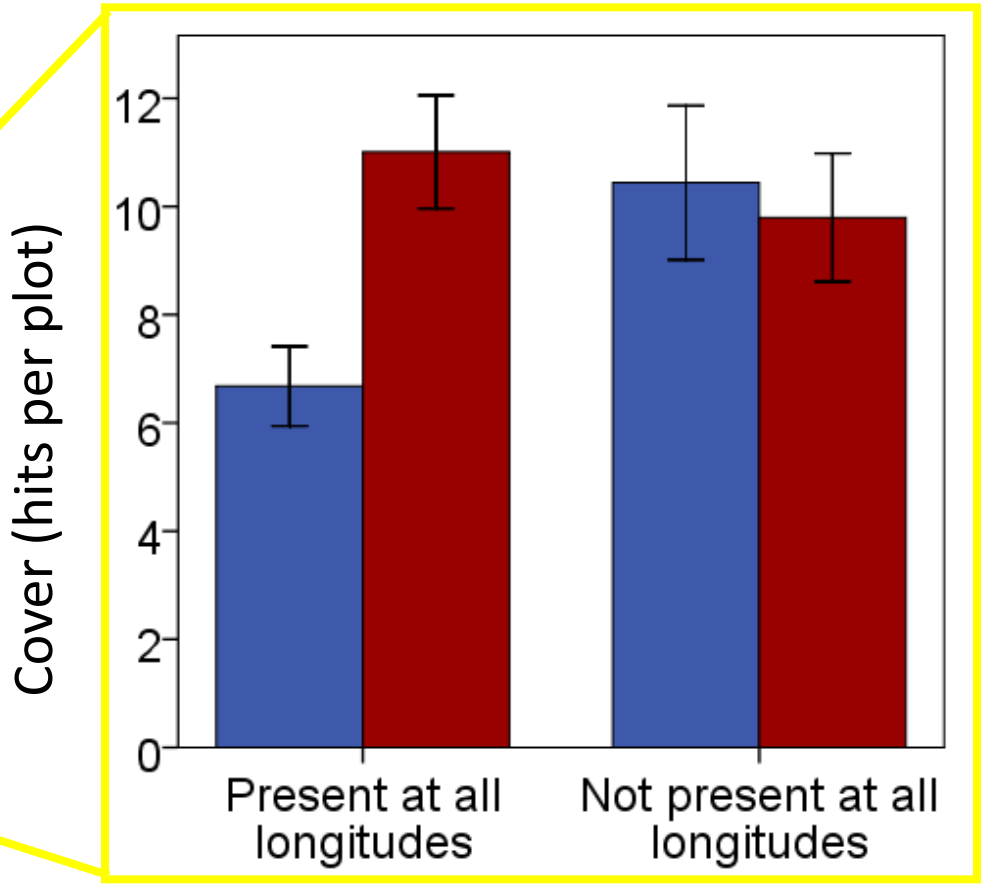
Warmed











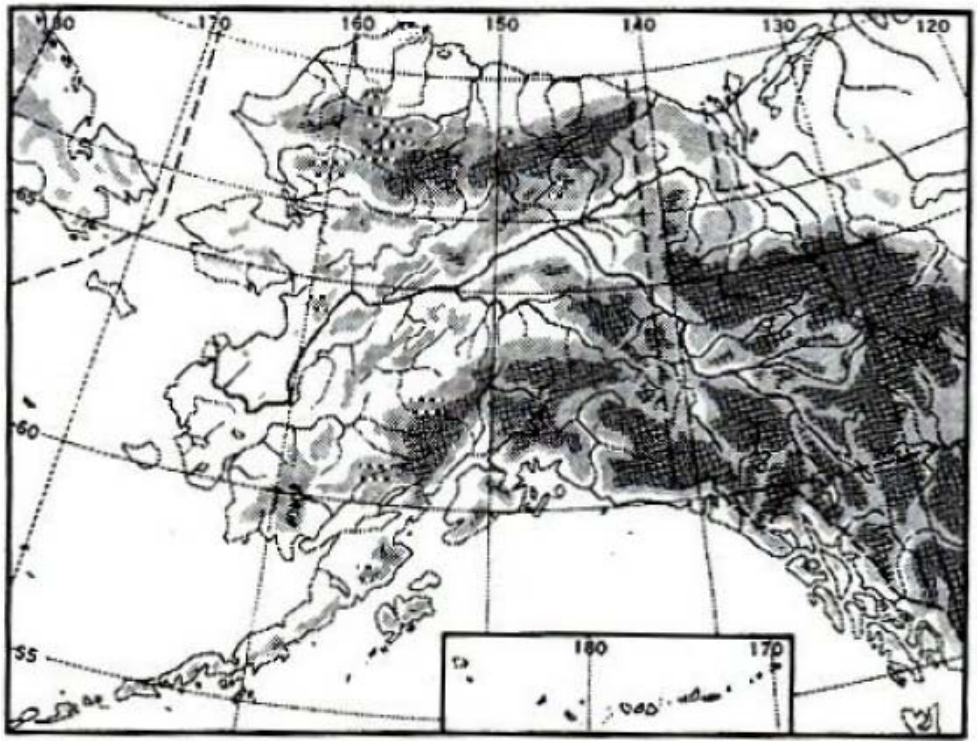
*p<.05

Results

	Latitudinal Distribution	Longitudinal Distribution
All Sites Combined		
Atqasuk Dry		
Atqasuk Wet	·	
Barrow Dry		*
Barrow Wet		

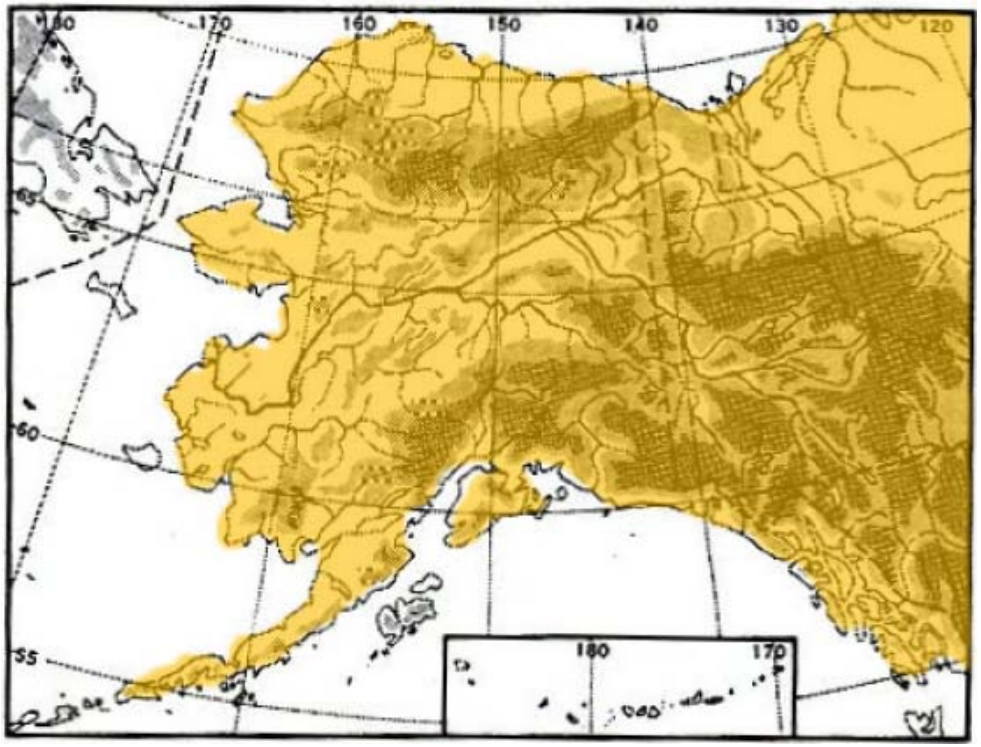
The Longitudinal Distribution group is only a useful predictor at the Barrow Dry site.

*p<.05, ·p<.10



Alaskan Distribution

Hultén 1968



Alaskan Distribution

Hultén 1968

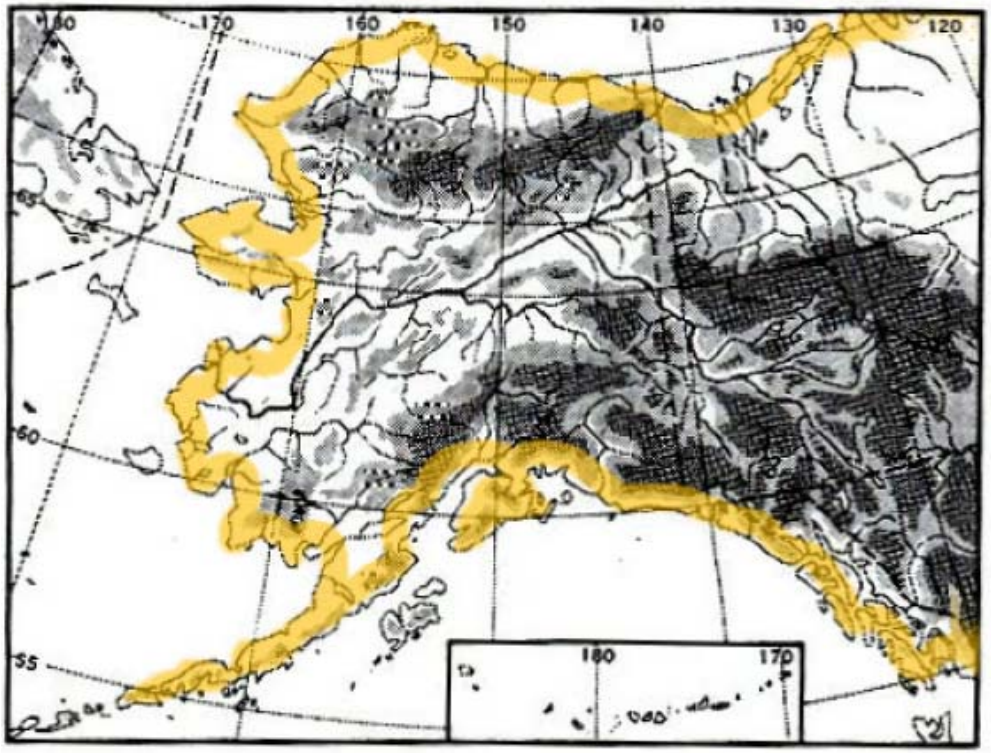
1: present throughout Alaska

2: present on north and south coasts

3: southern limit is north of southern coast

4: present in central AK, not at N or S coasts

5: northern limit is south of northern coast



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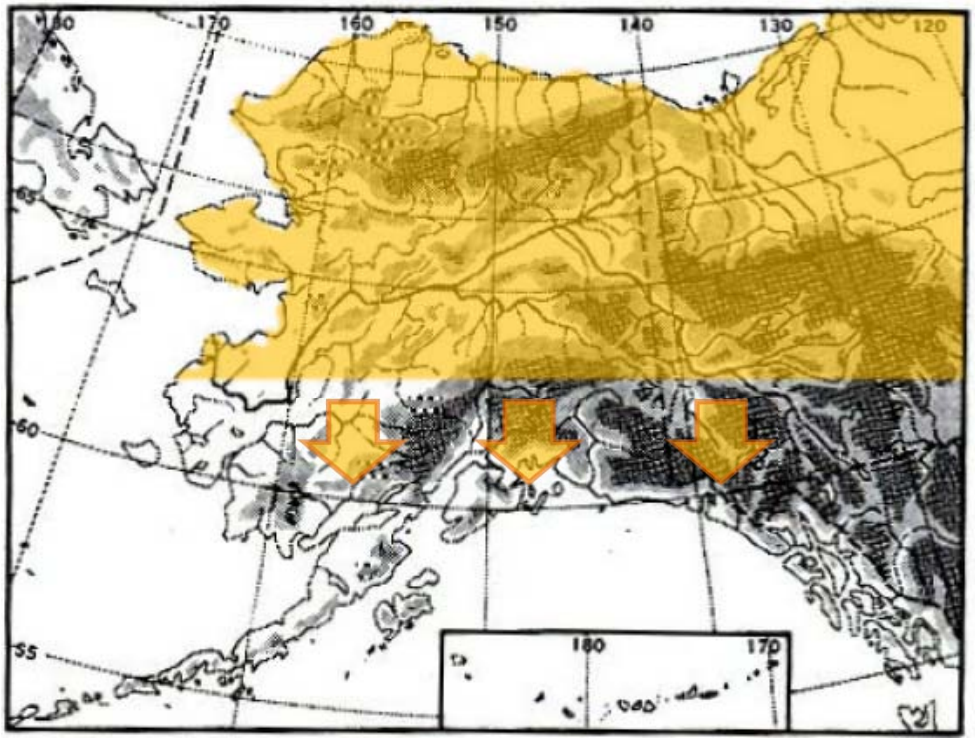

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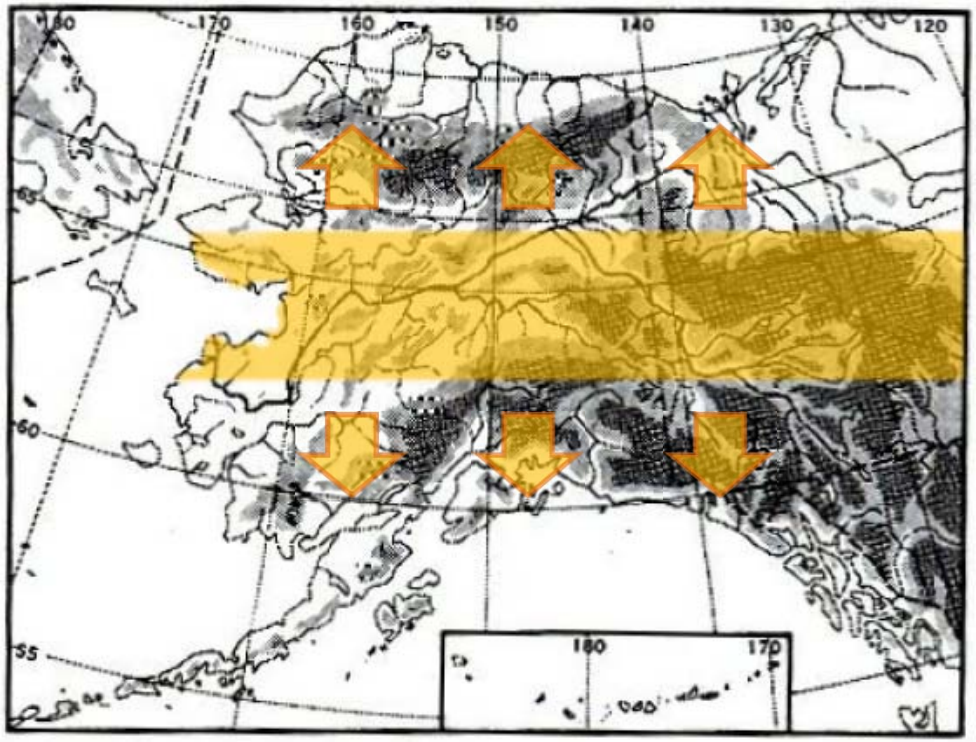
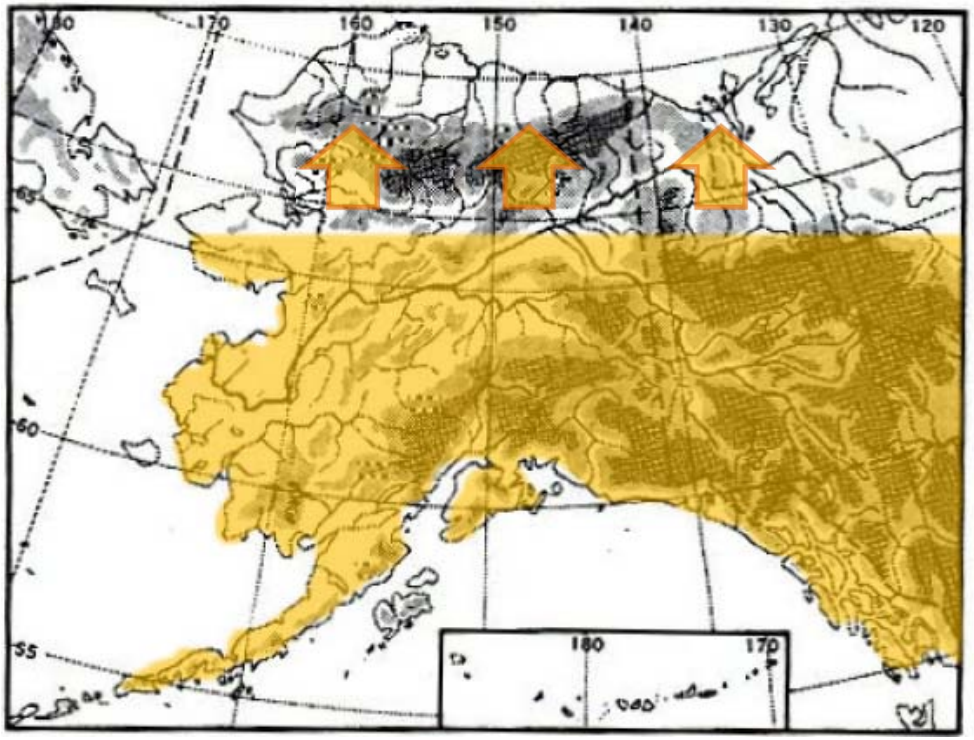


Alaskan Distribution

Hultén 1968

Carex aquatilis sub. *Stans* (Group 3)

1: present throughout Alaska
2: present on north and south coasts
3: southern limit is north of southern coast
4: present in central AK, not at N or S coasts
5: northern limit is south of northern coast



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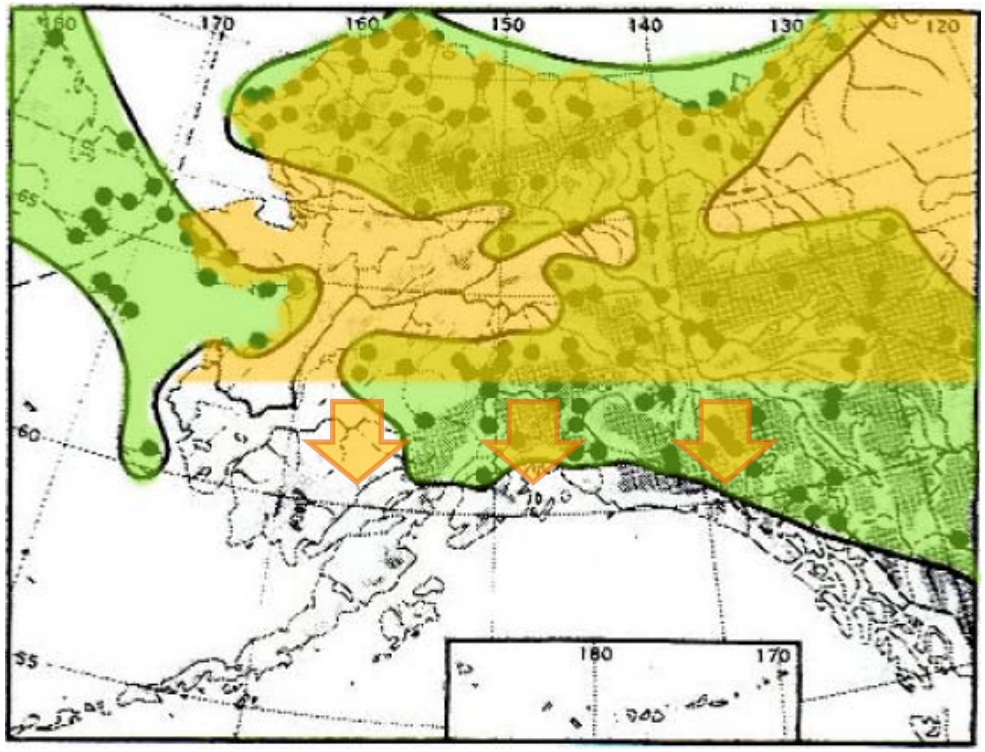
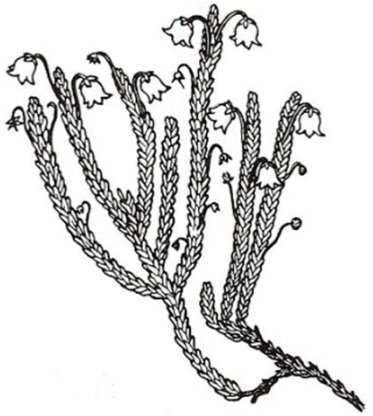


Alaskan Distribution

Hultén 1968

Cassiope tetragona
(Group 3)



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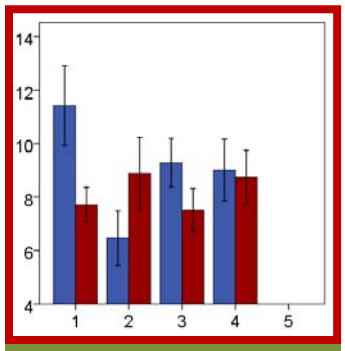
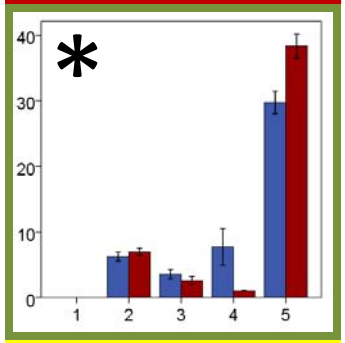
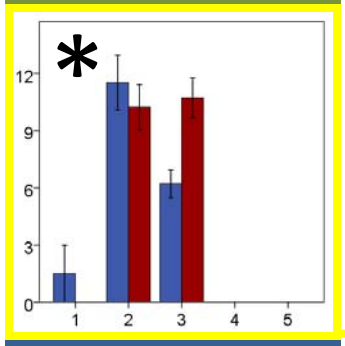
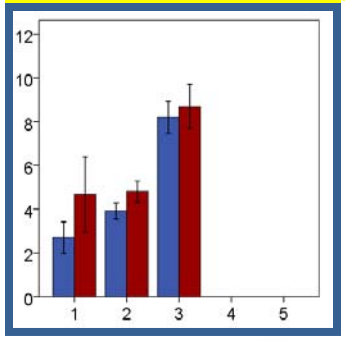
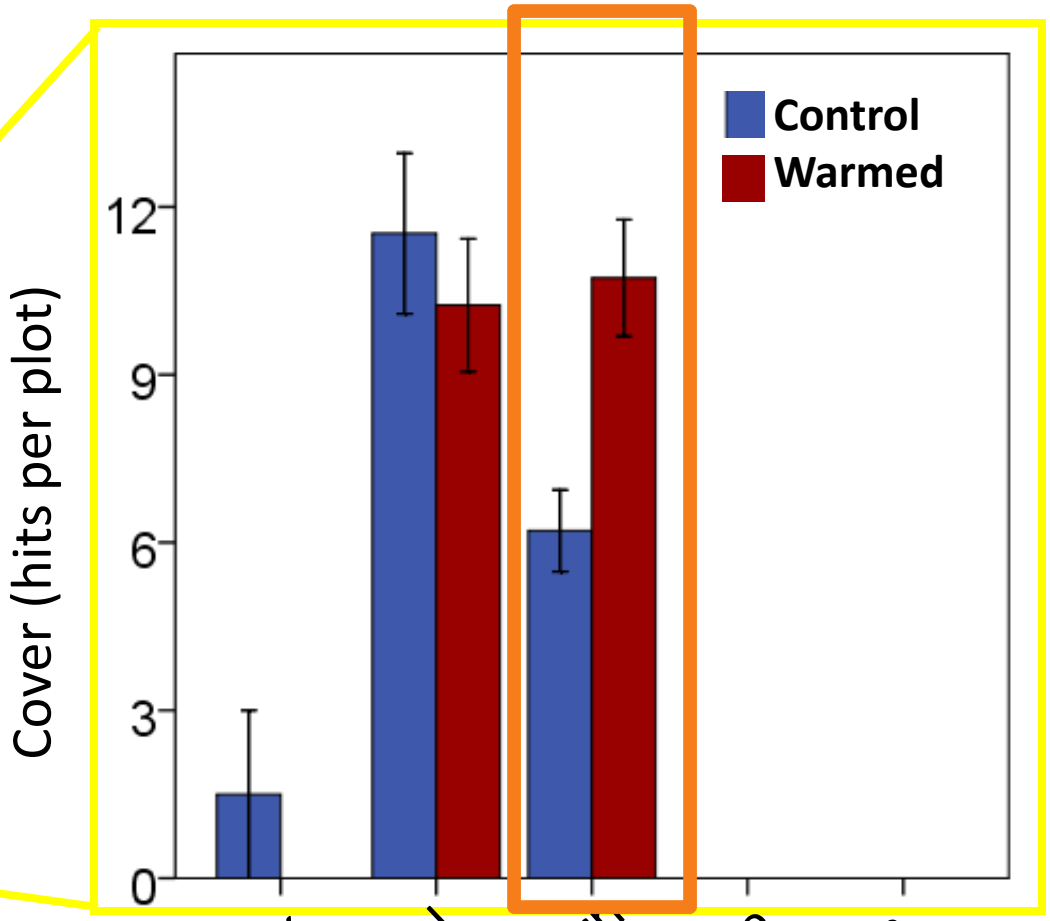
Alaskan Distribution





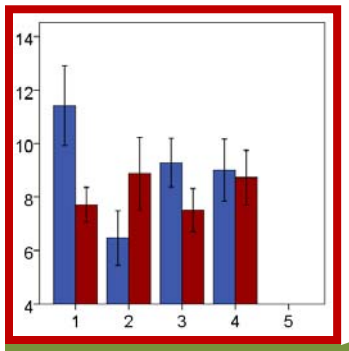


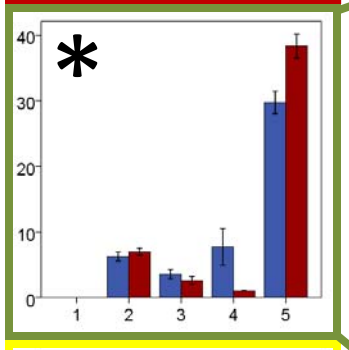


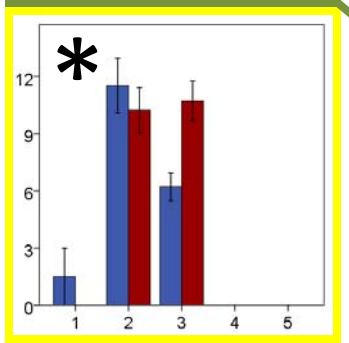


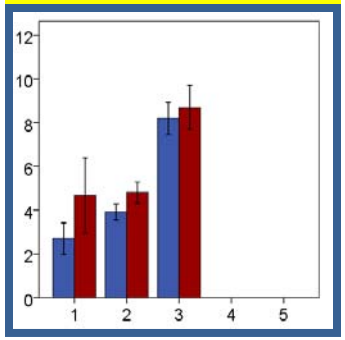
*p<.05

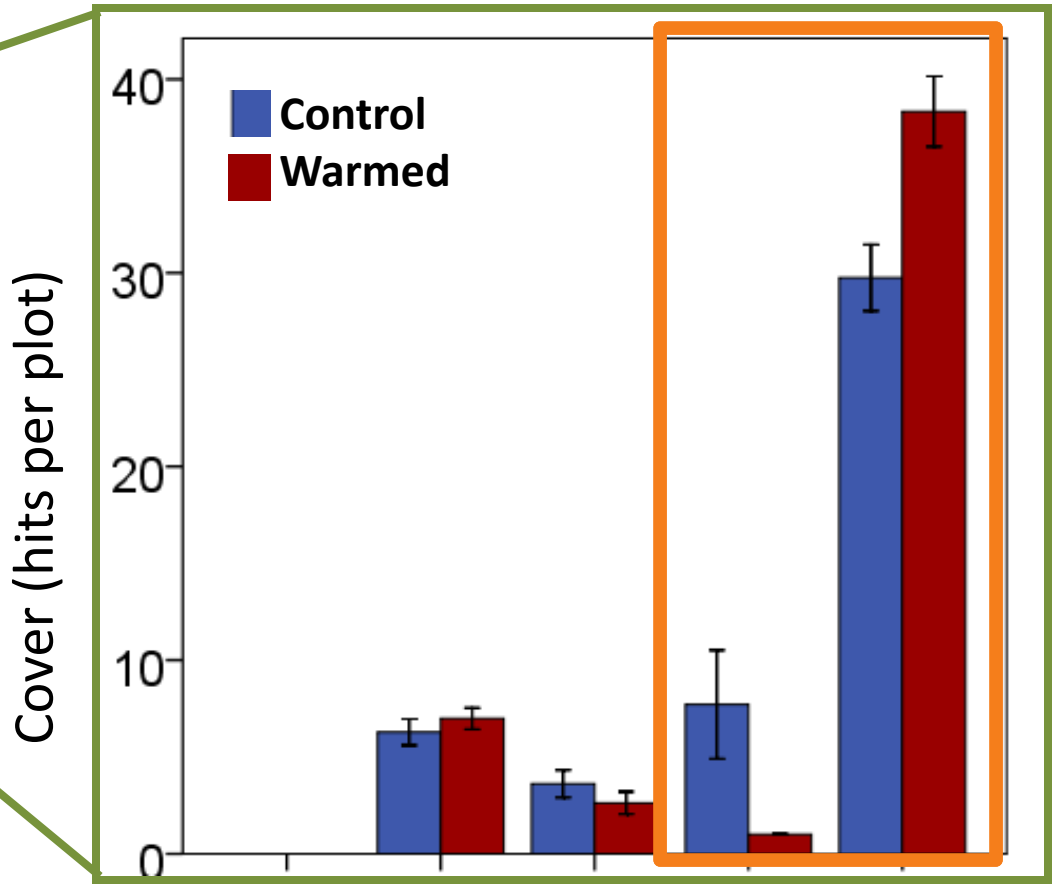
Alaskan Distribution











*p<.05

Conclusions

	Latitudinal Distribution	Longitudinal Distribution	Alaskan Distribution
All Sites Combined			*
Atqasuk Dry			
Atqasuk Wet	·		*
Barrow Dry		*	*
Barrow Wet			

The Barrow Dry Site is the most responsive of the four sites.

The Alaskan Distribution group is the most useful for predicting response to warming.

The sites respond to warming differently and different grouping schemes will be useful for each.

*p<.05, ·p<.10

Current and Future Questions

- Are there good predictors of community response to warming?
- Other geographic grouping schemes are being looked at to see if they agree with this investigation:
  - Young (1971)
  - Sørensen (1938)
- Other grouping schemes are being developed, based on
  - Morphology
  - Development
  - Phenology

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Thank you!